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CONSOLIDATED VULTEE

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DIVISION San Diego

MODEL XFY-1

REPORT CVAL 107A

DATE 3-31-53

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TITLE

ADDITIONAL LOW-SPEED WIND-TUNNEL TESTS OF A .15-SCALE POWERED MODEL OF THE XFY-1 AIRPLANE WITH 57° WING LEADING-EDGE SWEEPBACK

(Tested 11-3-52 to 11-21-52)

SUBMITTED UNDER
Navy Contract Noa(s) 51-936

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INTRODUCTION

This report presents data from low-speed wind-tunnel tests of a powered .15 scale model of the Convair XFY-1 airplane. The tests were conducted in the 8- by 12-foot test section of the Convair Wind Tunnel during the period of November 3 thru 21, 1952. These tests were authorized under Navy Contract NO a(s) 51-936 and were accomplished in 82.5 wind tunnel hours.

The purpose of these tests was to investigate the effect of split and extended chord elevons, and various wing leading-edge stall-control devices on longitudinal and lateral control in pitch during transitional and hovering flight conditions. In addition, a modified vertical tail and rudder was tested which was designed to reduce directional stability in normal flight and to increase directional control in hovering flight. The basic configuration consisted of the complete model with wing, body, vertical tails, rudders, gun pods, and oleo struts, see photo no. 1. A three view drawing of the basic configuration is shown on page 7. The model was in good condition during the tests. Normal-flight tests were run at a dynamic pressure of 25.0 lbs/sq. ft. and transitional-flight tests at a dynamic pressure of 8.0 lbs/sq. ft. For normal-flight tests, the corresponding Reynolds number based on wing mean aerodynamic chord was 2.1×10^6 and for transitional-flight tests was 1.2×10^6.

MODEL AND METHODS

The basic model configuration for this series of tests was the same as for CVAL 107. In addition the following modifications were made to the model to fulfill the purpose of the tests as discussed above. Split and extended chord elevons were tested which had a chord extension of 50% of the basic elevon chord. Each elevon was split into inboard and outboard sections at 25% and 50% of the elevon length, see sketch page 12, photo nos. 6, 7, & 8. Tests were made with various combinations of split elevon deflections to determine longitudinal and lateral control effectiveness for transitional and hovering flight conditions. The following wing leading-edge stall-control devices were tested: leading-edge tongue, see sketch page 13, leading-edge glove, see sketch page 14, photo nos. 9 & 10, and leading-edge slat, see sketch page 15, photo no. 13. A modified vertical tail and rudder were tested which had increased leading-edge-sweepback and larger total rudder area than the basic configuration. The total fin area was smaller than the basic fin and was located farther forward to decrease stability during normal flight, see sketch page 16, photo nos. 11 & 12.

The model was supported in the test section by a special vertical strut and a horizontal sting, see photo no. 1. All runs were made by yawing the balance system. Pitch runs were made by rolling the model about its longitudinal axis to the desired roll attitude and then yawing the balance system to pitch the model, see photo no. 1. Yaw runs were made by yawing the balance system with the wings level, see photo no. 11. Six-component force data were recorded for all pitch and yaw runs. All runs were made with the horizontal sting set at 90° to the vertical support strut, see sketch page 11.

MODEL AND METHODS (Cont'd)

For this series of tests the model was located two inches farther away from the vertical support windshield than for CVAL Test 107, see sketch page 11. This change was made to move the model farther away from the vertical support windshield and thereby reduce the aerodynamic interference effects of the windshield on the model. Aerodynamic tare tests were made to determine the interference effects of the support windshield on the model for most of the conditions which were run during this series of tests.

For pitch tests with the model set at a constant roll angle the model did not pitch about its lateral Y - Y axis, see sketch page 24. Consequently, the defined geometric angles of attack and yaw did not coincide with the angles as set in the tunnel for this condition. Wind-tunnel reference angles are defined in sketch on page 24. Geometric reference angles as defined by NACA in TR-474 are shown in sketch on page 25. The relationship between wind-tunnel reference angles and defined geometric reference angles for pitch tests at constant roll angle have been evaluated and are presented in figure A. For all other tests wind-tunnel reference angles were the same as the defined geometric angles.

During transition and hovering runs the large change in blocking area over the angle of pitch range and the large blocking area involved at high angles of attack or yaw necessitated special blocking corrections. Constant dynamic pressure was maintained by changing the tunnel-motor speed with each change in model angle. The blocking corrections were determined experimentally during CVAL Test 107 from a pressure survey made in the test section of the tunnel with the model set at various angles of attack or yaw. From this survey a calibration was made to adjust tunnel-motor speed with each change in model angle in order to maintain constant dynamic pressure in the test section.

The data obtained from the pressure survey and an analysis of these data including the blocking corrections for this report are presented in CVAC Aero Memo A-5-35. A subsequent study and investigation of blocking corrections for the CVAL subsonic wind tunnel has been made and is presented in CVAL 107, Addendum I, to be published under separate cover.

To improve the accuracy of tunnel-motor speed control at low dynamic pressures, a cheese-cloth net was placed across the main section of the tunnel at the first set of vanes downstream of the tunnel propeller, see photo no. 2. The net absorbed a portion of the stream energy imparted by the tunnel propeller and allowed the tunnel-motor to be run at a higher speed with improved accuracy of control for a given dynamic pressure. This net was in the tunnel during all tests.

Data were recorded for various ranges of angles depending on the flight condition listed below.

Normal Flight	Pitch	-2° to 28°
	Yaw	-10° to 20°

MODEL AND METHODS (Cont'd)

Transitional Flight Pitch -15° to 28°
" 10° to 90°

Hovering Flight (with crosswind)

Crosswind tending to increase angle of attack $V_z/V_{s_\infty} = 0$ to .376

Hovering Flight (with crosswind)

Crosswind tending to increase angle of yaw $V_y/V_{s_\infty} = 0$ to .376

Hovering tests were made by setting the model at a constant tilt angle and then varying the tunnel speed to simulate a crosswind. Several points were taken at each crosswind setting to investigate the aerodynamic spread of force and moment components.

For all hovering runs at zero tilt angle the window of the test section which was directly behind the model was opened in order to better simulate the condition of hovering flight in free air, see photo no. 3. Model thrust was held constant during all hovering runs.

Model thrust was developed by a controllable-speed electric motor driving scale size contra-rotating propellers. All propeller calibration data was taken from CVAL Test 107. For transitional and hovering flight tests, the propeller blade angle was set for zero model torque for condition of static thrust. The motor-propeller combination was calibrated for constant T_c' settings as shown in figures B and C. During normal and transitional flight, thrust was set and held constant by varying the model motor RPM with each change in angle of attack or yaw. Because the propeller calibration for normal flight runs was made with wing and tails intact on the model for both power off and power on runs it is believed that the RPM settings are slightly higher than actually required. Propeller calibration for transitional and hovering runs was made with wing and tails removed from the model. The T_c' settings were determined from full scale performance data and were chosen as representative of the flight range under investigation. During hovering tests model thrust was held constant by varying the model motor RPM with each change in tunnel speed, see figure D.

RESULTS

All force data are presented in coefficient form in figures 1-17. Normal-flight force data are presented in figures 1-2, transitional-flight force data in figures 3-11, and hovering-flight force data in figures 12-17. Moment data

RESULTS (Cont'd)

are transferred to a center of moments located at 14% of the mean aerodynamic chord and .631 inches model scale above the thrust line, see sketch page 8.

Normal-Flight Data

Primary components of force data for normal-flight runs are presented in figures 1 and 2. These data are presented in coefficient form and are referred to stability axes. Stability axes are defined as axes which yaw with the model but do not pitch, see sketch page 28 for definition of stability axis notation. Force coefficients are based on wing area and pitching moment coefficient on wing area and mean aerodynamic chord. Rolling and yawing moment coefficients are based on wing area and span. Wall corrections based on unswept wing theory were applied to angle of attack and drag data. Aerodynamic tares from CVAL Test 107 to correct for the interference effect of the support windshield were applied to all normal flight data. Free stream dynamic pressure was corrected for blocking effects based on the frontal area of the model.

Transitional-Flight Data

Primary components of transitional-flight data are presented on figures 3-11. Data which pertain mainly to longitudinal stability and control are referred to stability axes in figures 3-6. Data which pertain mainly to lateral control in pitch are referred to body axes in figures 4-11. The lateral components of transitional-flight data, particularly rolling moment were in general erratic and difficult to repeat for angles of attack from 50° to 90°. Body axes are defined as three mutually perpendicular axes, through the center of moments, of which the longitudinal and lateral axes are in a plane parallel to the wing reference plane and the longitudinal axis is also in the plane of symmetry. The NACA sign convention for body axes is used where the normal force is positive down and axial force positive forward, see sketch page 29 for definition of body axis notation. Force and moment coefficients are based on the same terms as used for normal flight data. Wall corrections were not known for the transitional flight condition and were not applied. Aerodynamic tares to correct for the interference effect of the support windshield were applied to all transitional flight data except in figure 3, where tares were not known for the particular conditions involved. Tares for other transitional-flight data were determined during this series of tests. Blocking corrections were taken from CVAL Test 107 and were applied with each change in model angle to maintain constant free stream dynamic pressure.

Hovering-Flight Data

In general only the primary components of force data for hovering flight are presented in figures 12-17. All moment coefficients presented for hovering

RESULTS (Cont'd)

Hovering-Flight Data (Cont'd)

flight are referred to body axes. Force coefficients are all referred to body axes except in figure 17 where they are referred to wind axes. Wind axes are defined as always parallel and perpendicular to the tunnel wind direction, see sketch page 26. NACA sign convention is used for body axes, see sketch page 29.

All hovering data are plotted against the ratio of crosswind velocity to the theoretical slipstream velocity of the propeller as the independent variable. The theoretical dynamic pressure of the propeller slipstream at a large distance behind the propeller disc was used as a basis for all force and moment coefficients. This was considered to be model thrust divided by propeller disc area. In addition force coefficients are based on model wing area and pitching moment coefficient on wing area and mean aerodynamic chord. Rolling and yawing moment coefficients are based on wing area and span. No wall corrections were applied to hovering data. Aerodynamic tares to correct for the interference effect of the support windshield were applied to all hovering data except in figure 17, where tares were not known for the conditions involved. In figures 12-14 tares were applied which were determined during this series of tests. In figures 15 and 16 tares were taken from CVAL Test 107.

Blocking corrections for determination of crosswind dynamic pressure were taken from CVAL Test 107 and were applied in the same manner as for transitional flight data.

Aerodynamic Tares

Extensive tare tests were made for this model during CVAL Test 107 to evaluate the interference effects of the support windshield on the forces and moments measured on the model. Since the model was mounted two inches farther away from the support windshield for this series of tests, additional tare tests were made during this series of tests to evaluate the tare for this condition, see sketch page 11. The procedure used for tare evaluation was the same as for CVAL Test 107. This procedure was to simulate a portion of the lower windshield on the top of the main support windshield and to test this configuration at the same tunnel speed and model power setting as was the configuration for which the tare evaluation was sought, see sketch page 17, photo no. 14. The tare run was then compared with a base run made with the same model configuration, tunnel speed and power condition but without the added portion of the support windshield. The portion of the support windshield which was added to the main windshield was designed to simulate that part of the main windshield which affected the model for a given set of test conditions.

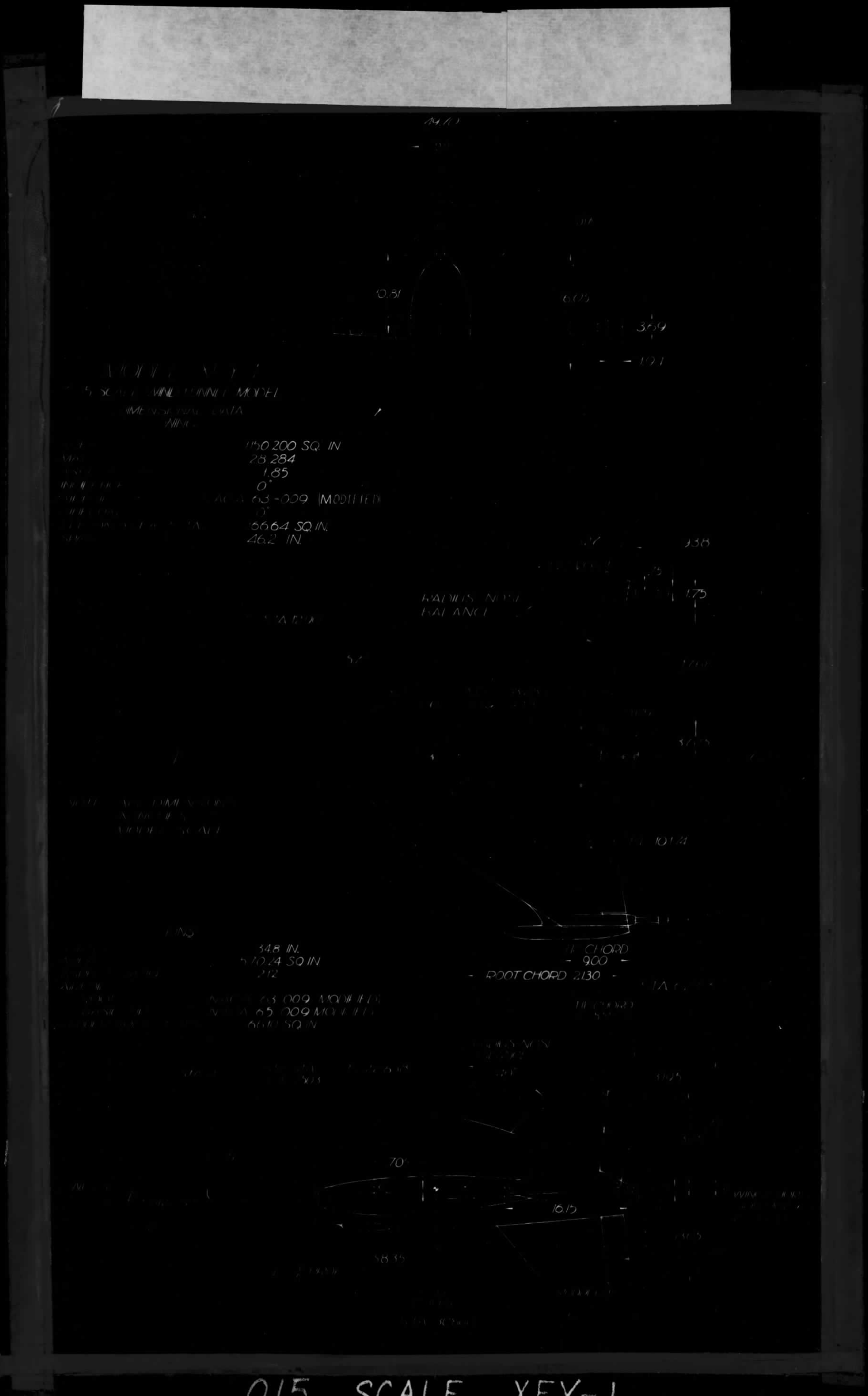
Aerodynamic tares and the tare runs from which they were obtained are not presented in this report but are on file at the Convair Wind Tunnel.

RESULTS (Cont'd)

Aerodynamic Tares

Tares were run in this manner for transitional and hovering flight conditions with certain exceptions previously noted where tares were taken directly from CVAL Test 107 as in figures 1, 2, 15, and 16 of this test or were not applied, as in figures 3 and 17.

Aerodynamic tares and the tare runs from which they were obtained are not presented in this report but are on file at the Convair Wind Tunnel.



0.15 SCALE XFY-1
GENERAL ARRANGEMENT

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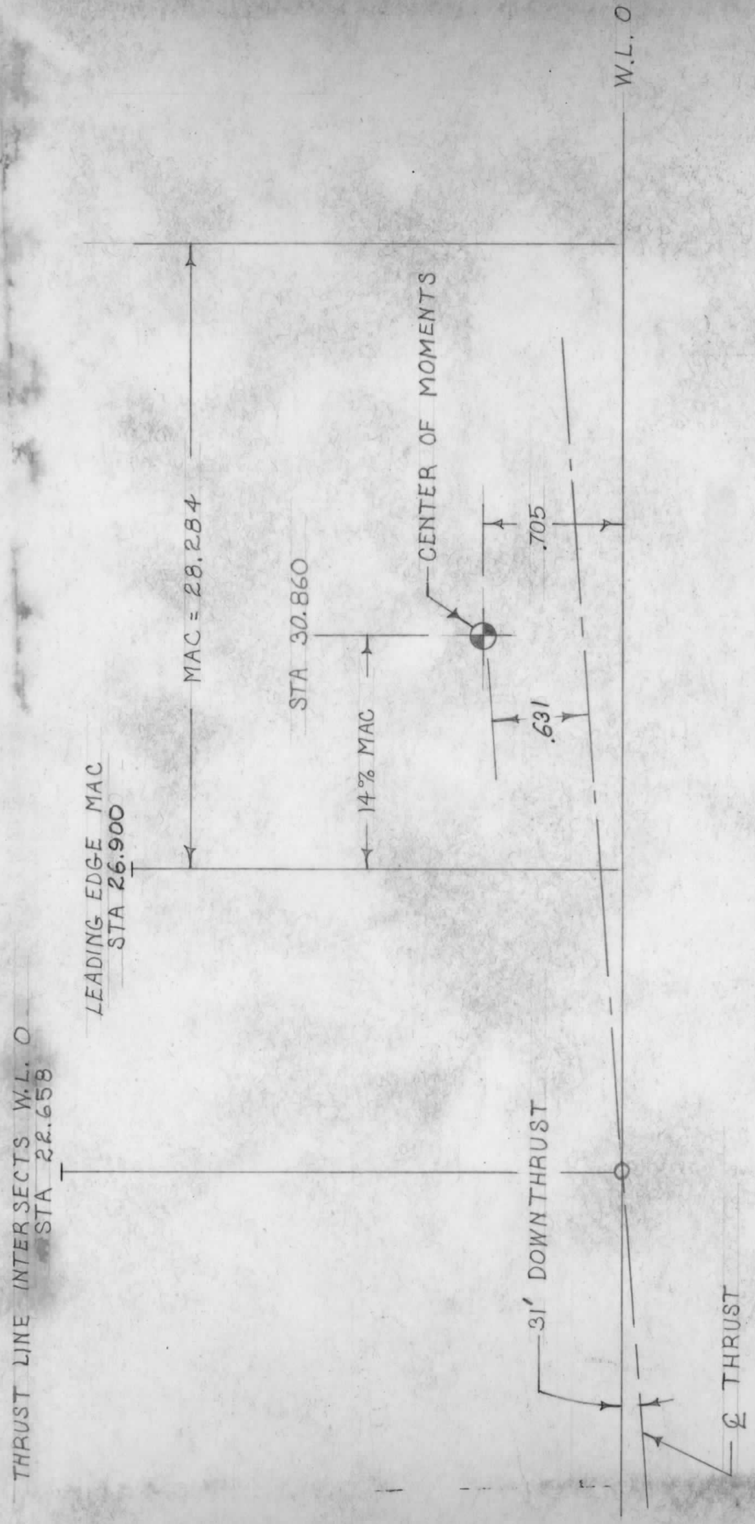

ALL DIMENSIONS INCHES MODEL SCALE

WING AREA = 7.988 FT^2
WING SPAN = 46.20 INCHES

MOMENT REFERENCE DIAGRAM

.15 SCALE XFY-1 CVAL 107A

SKETCH NOT TO SCALE

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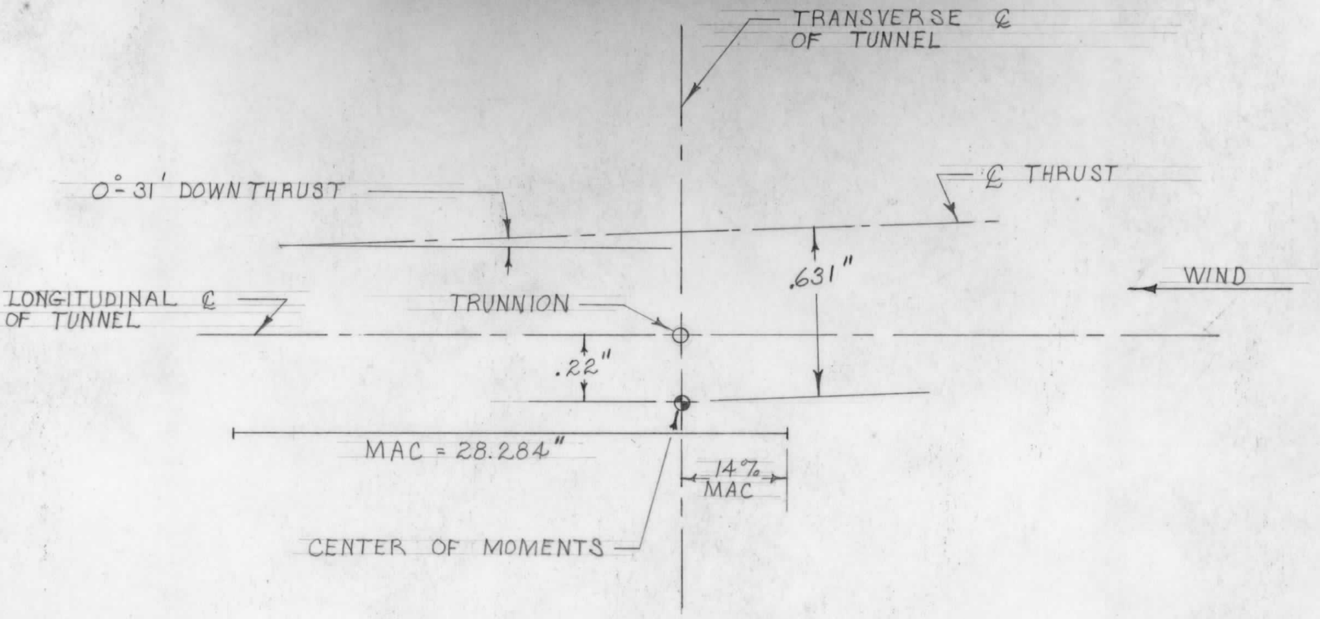
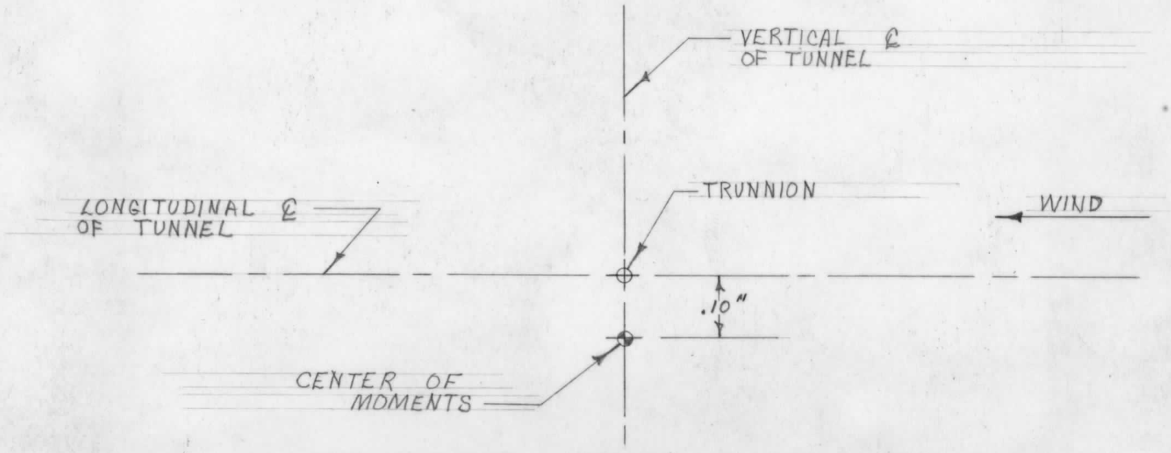


PLAN VIEW OF TUNNEL & SIDE VIEW OF MODEL



SIDE VIEW OF TUNNEL & PLAN VIEW OF MODEL

NOTE-
ALL DIMENSIONS ARE INCHES MODEL SCALE

MOMENT TRANSFER DIAGRAM
MODEL RIGGED FOR PITCH RUNS

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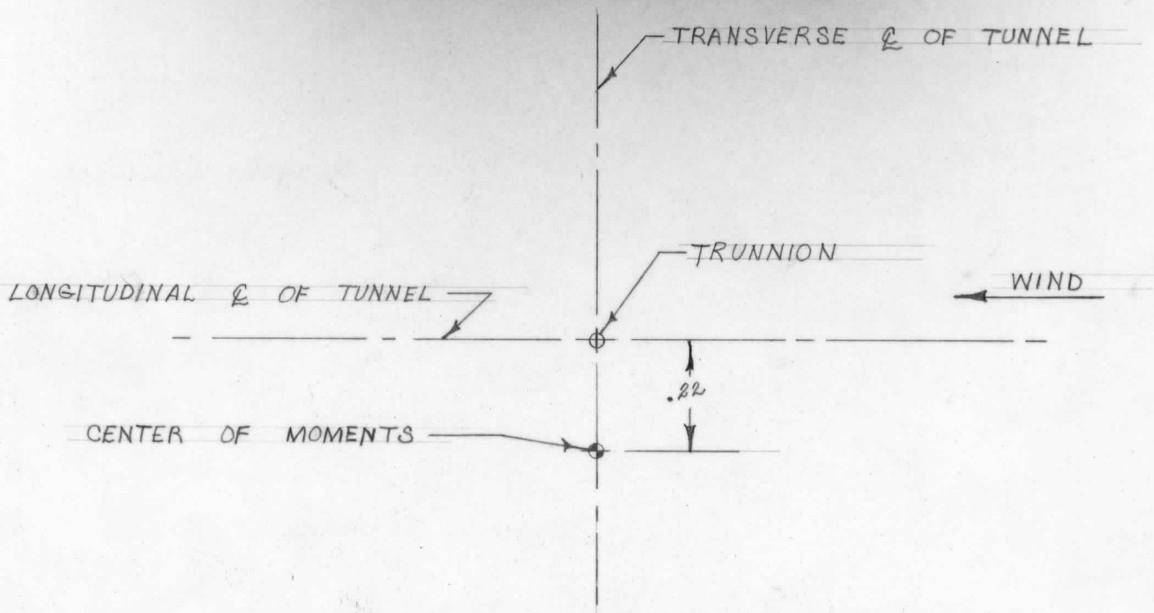
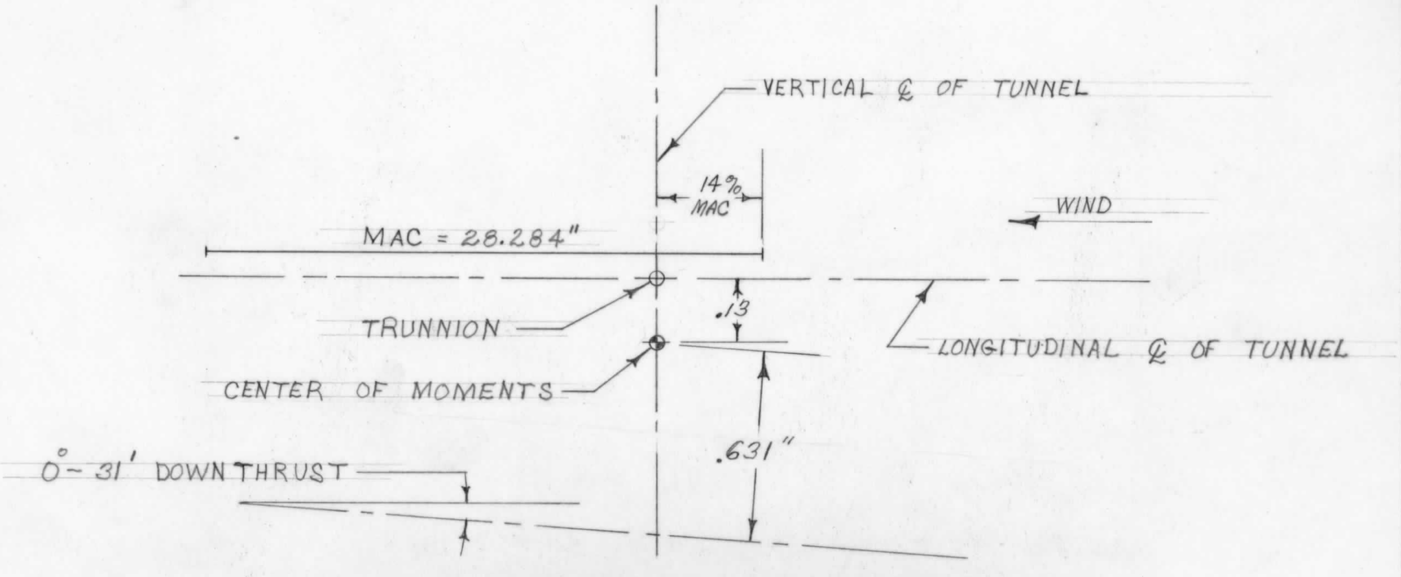


PLAN VIEW OF TUNNEL & MODEL



SIDE VIEW OF TUNNEL & MODEL

NOTE -
ALL DIMENSIONS ARE INCHES MODEL SCALE

MOMENT TRANSFER DIAGRAM
MODEL RIGGED FOR YAW RUNS

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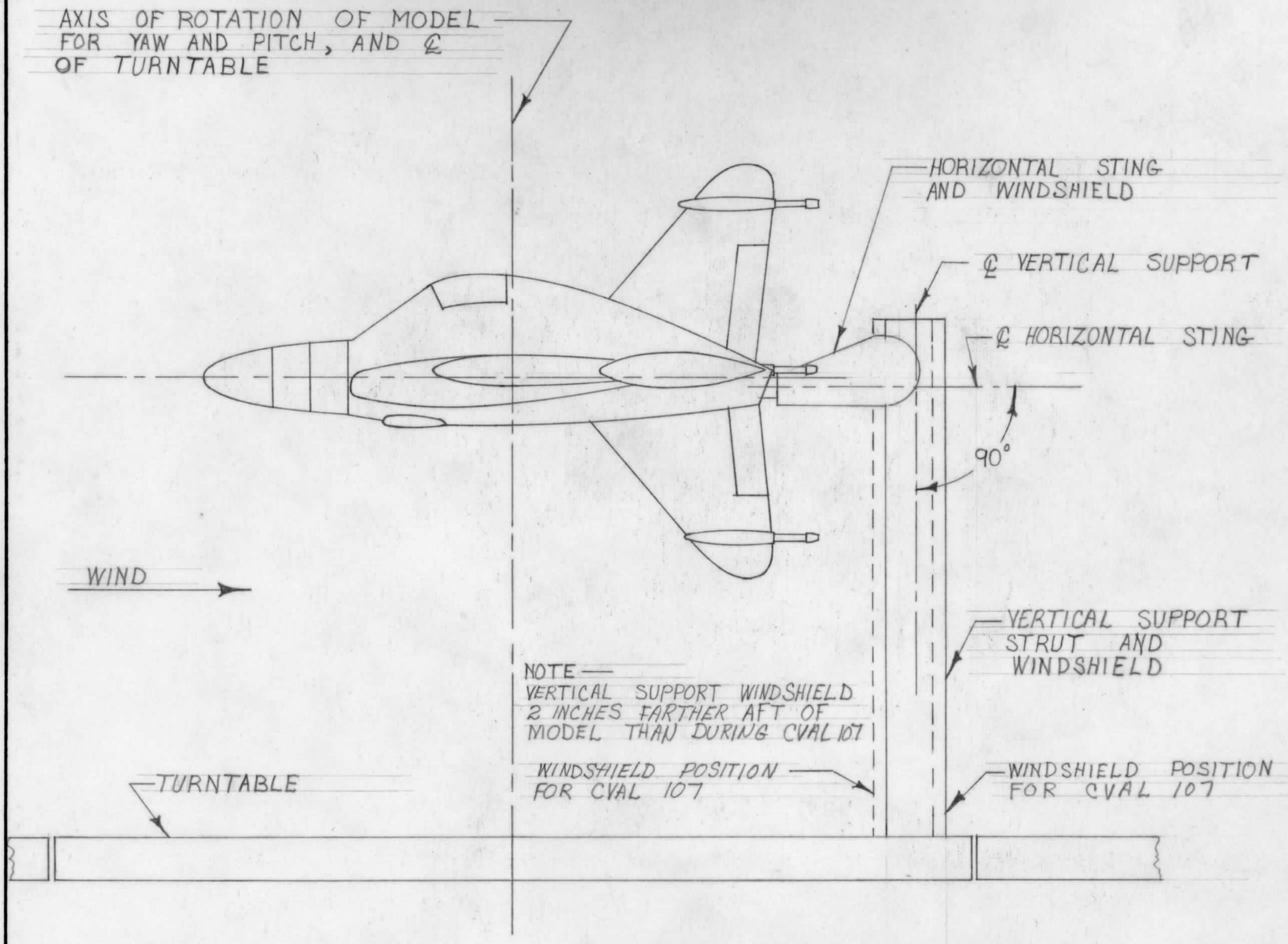
AXIS OF ROTATION OF MODEL FOR YAW AND PITCH, AND ℄ OF TURNTABLE
HORIZONTAL STING AND WINDSHIELD
℄ VERTICAL SUPPORT
℄ HORIZONTAL STING
90°
WIND
VERTICAL SUPPORT STRUT AND WINDSHIELD
WINDSHIELD POSITION FOR CVAL 107
WINDSHIELD POSITION FOR CVAL 107
TURNTABLE

NOTE—
VERTICAL SUPPORT WINDSHIELD 2 INCHES FARTHER AFT OF MODEL THAN DURING CVAL 107

NOTE—
INSTALLATION FOR PITCH TESTS SAME AS YAW TESTS EXCEPT MODEL ROLLED 90° ABOUT ITS LONGITUDINAL AXIS

MODEL SUPPORT & INSTALLATION FOR YAW TESTS

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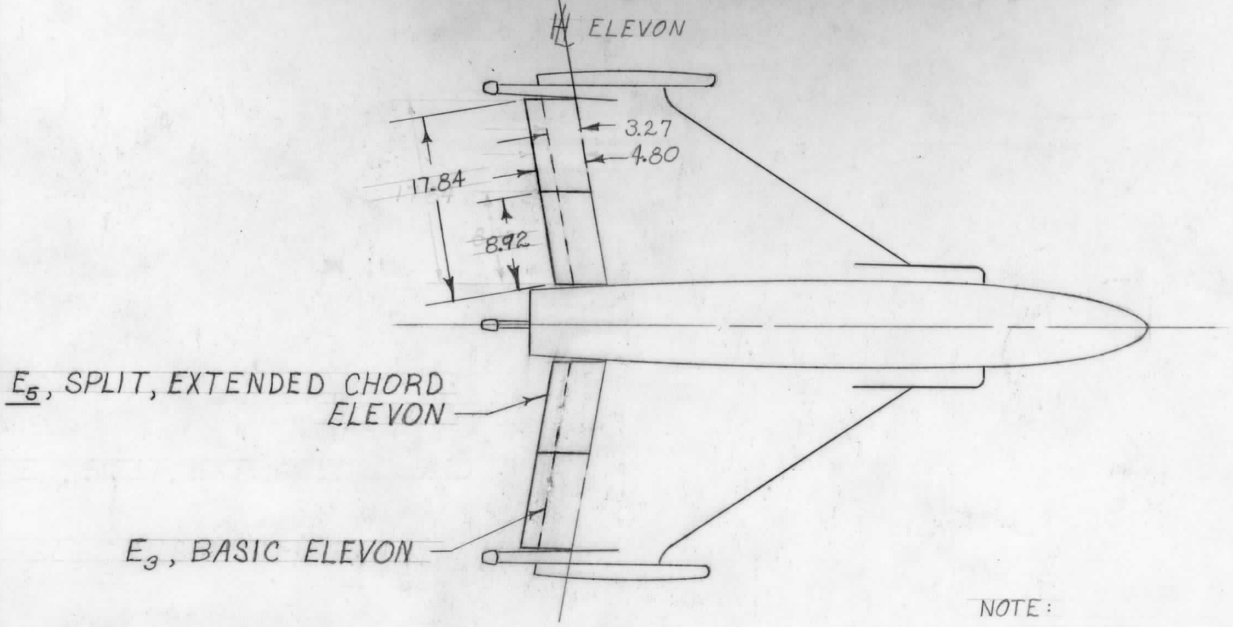
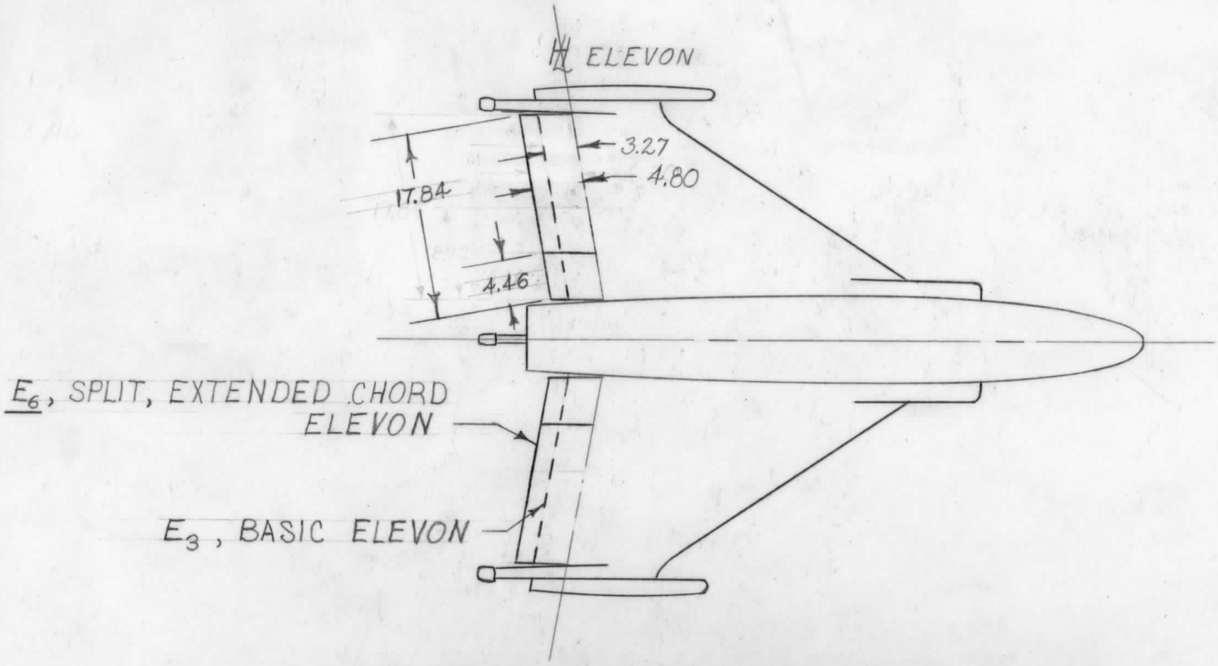


NOTE:

ALL DIMENSIONS ARE INCHES MODEL SCALE



E_5, E_6 SPLIT, EXTENDED CHORD ELEVONS

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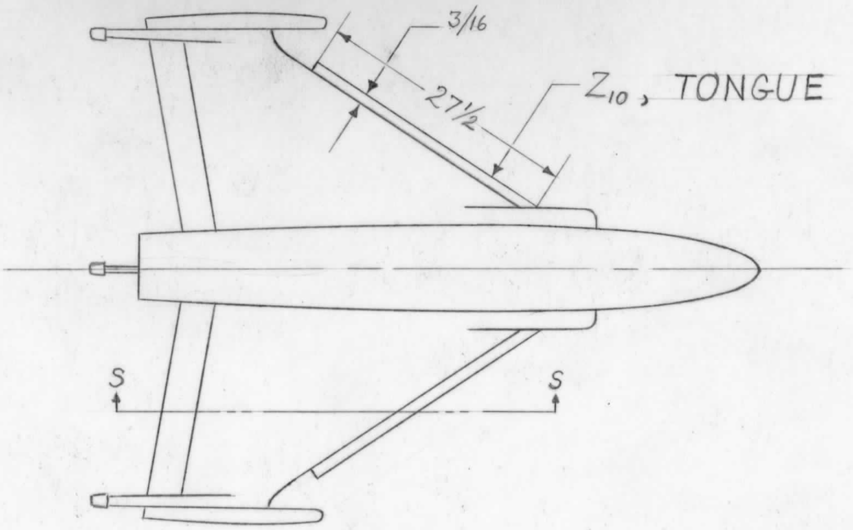
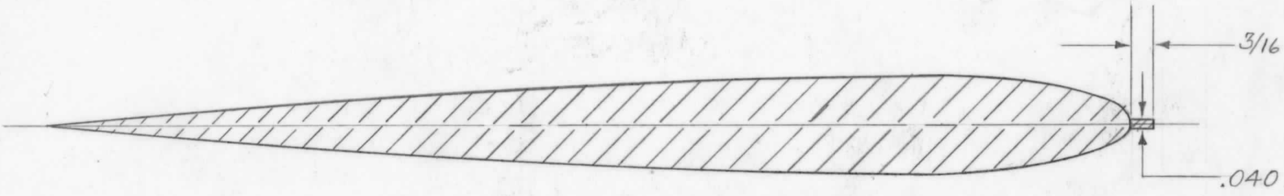
NOTE:
ALL DIMENSIONS ARE
INCHES MODEL SCALE





SECTION S-S

Z_{10}, LEADING EDGE TONGUE

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NOTE:
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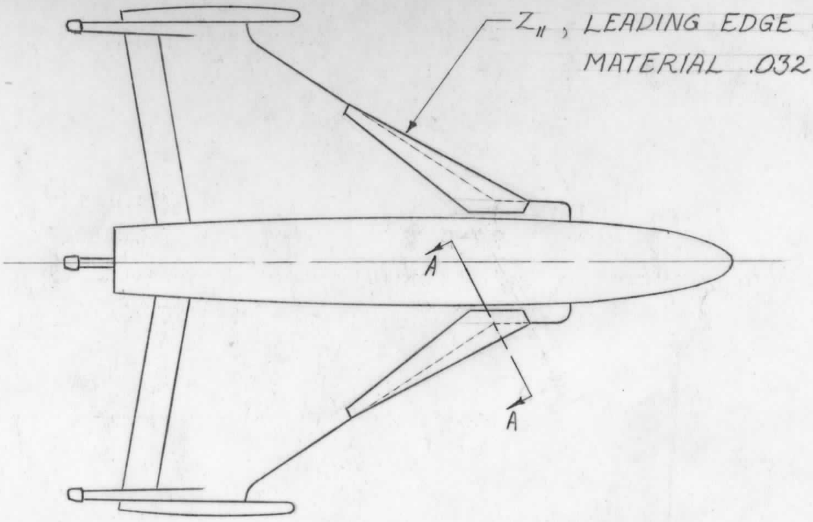
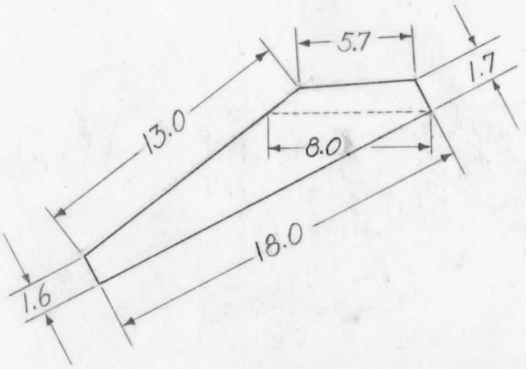
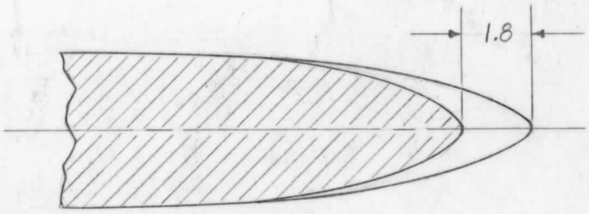


Z_{11}, LEADING EDGE GLOVE
MATERIAL .032 24 SO



PLAN VIEW OF RH GLOVE



SEC. A-A

Z_{11} LEADING EDGE GLOVE

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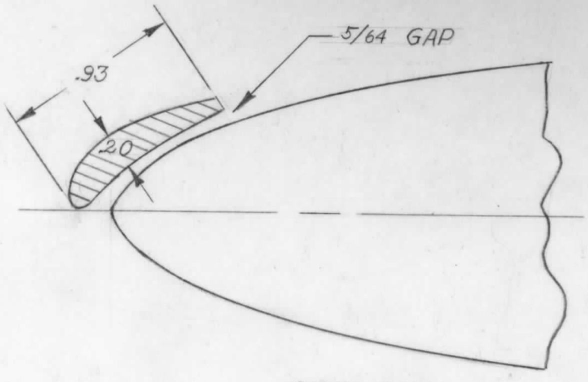
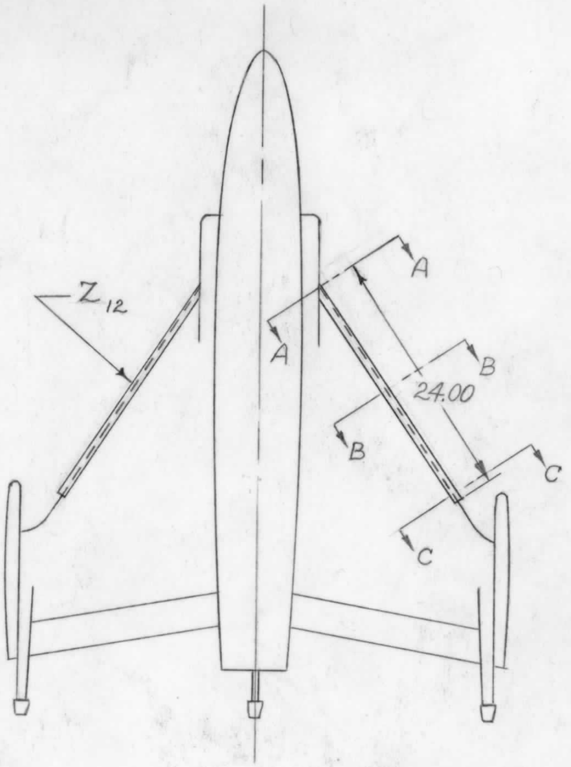
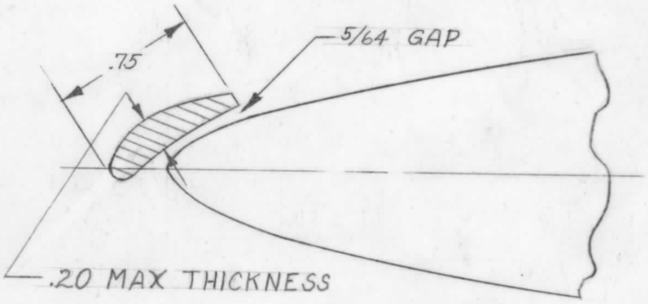
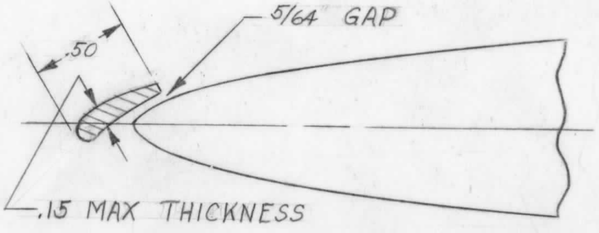


SEC. A-A





SEC. B-B



SEC. C-C

NOTE:
ALL DIMENSIONS ARE
INCHES MODEL SCALE

Z_{12}, LEADING EDGE SLAT

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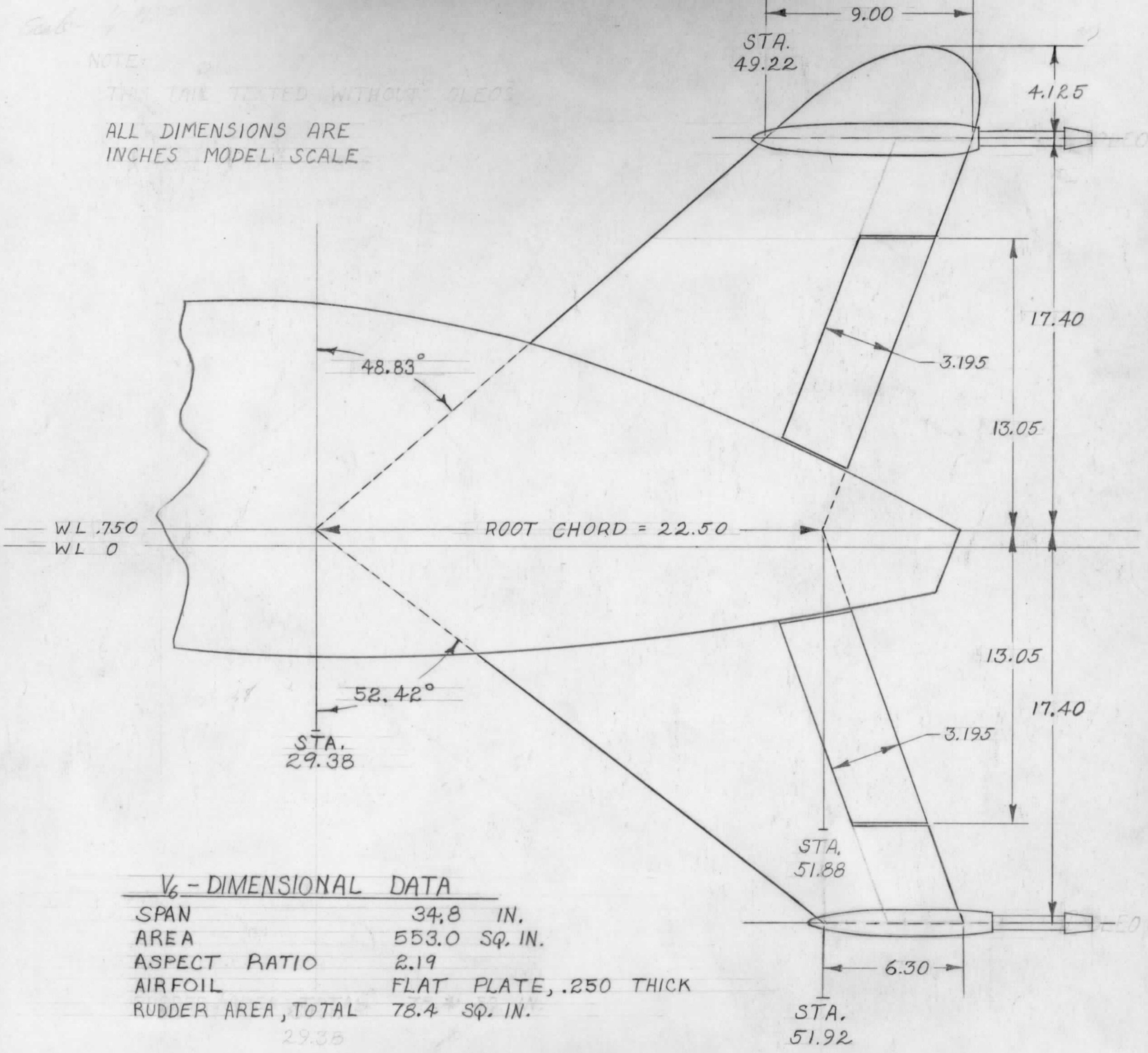

V_6 - DIMENSIONAL DATA

SPAN	34.8 IN.
AREA	553.0 SQ. IN.
ASPECT RATIO	2.19
AIRFOIL	FLAT PLATE, .250 THICK
RUDDER AREA, TOTAL	78.4 SQ. IN.

V_6, MODIFIED VERTICAL TAIL & RUDDERS

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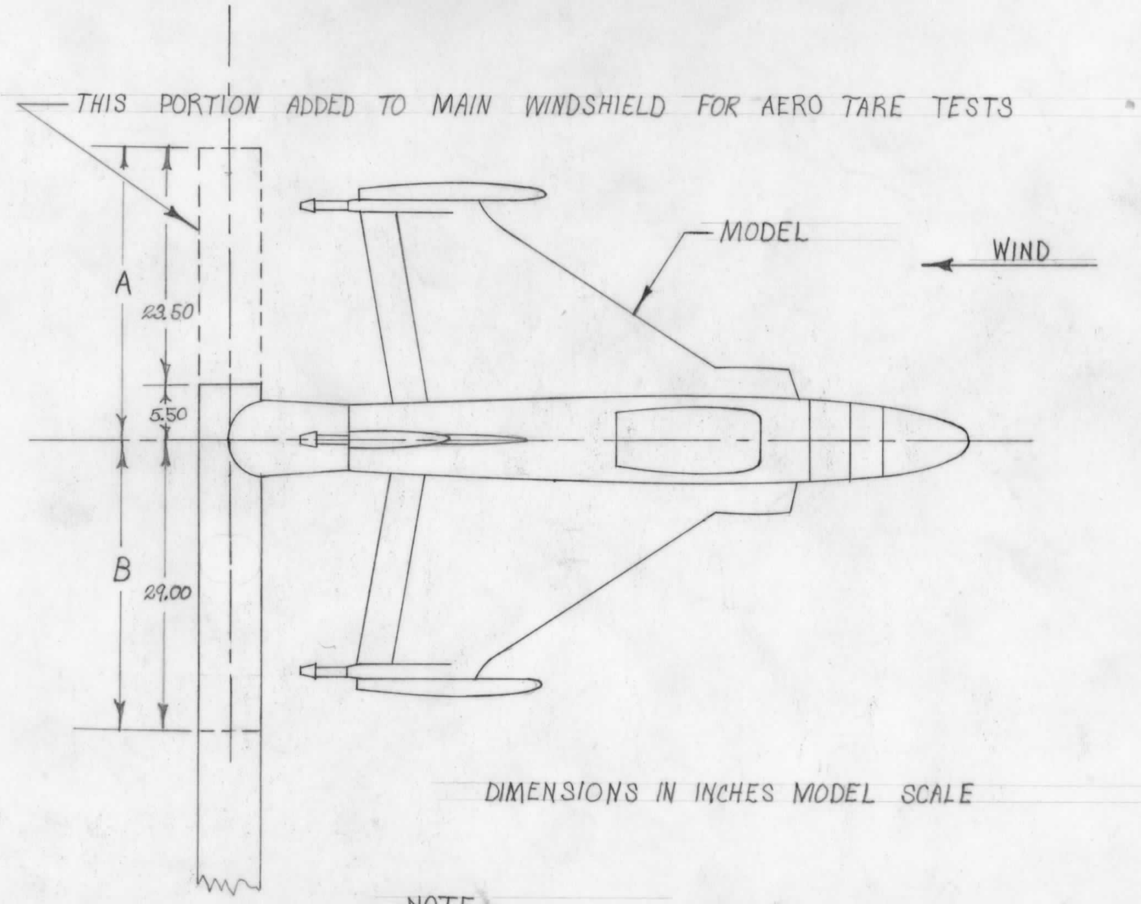
THIS PORTION ADDED TO MAIN WINDSHIELD FOR AERO TARE TESTS
MODEL
WIND
A
23.50
5.50
B
29.00
DIMENSIONS IN INCHES MODEL SCALE

NOTE –
FOR AERO TARE TESTS SECTION "A" SIMULATES THE INTERFERENCE EFFECT OF SECTION "B" DURING NORMAL TESTS

SUPPORT WINDSHIELD ADDITION FOR AERO TARE TESTS
MODEL RIGGED FOR PITCH RUNS

DESCRIPTION OF MODEL COMPONENTS

Symbol	Description	Page No.	CVAC Dwg. No.
S_3	Complete model ($W_3E_3B_3V_3R_3O_3M_3F_3$)	7	WT-51-5022
S_3^o	Complete model, canopy open ($W_3E_3B_3^oV_3R_3O_3M_3F_3$)	62	WT-51-5022
W_3	Wing	7,62	WT-51-5018
E_3	Both elevons	7,62	WT-51-5018
E_5	Split, extended chord elevons, split 50-50	12	
E_6	Split, extended chord elevons, split 75-25	12	
B_3	Body, canopy closed	7,67	WT-51-5023 WT-51-5020
B_3^o	Body, canopy open	62,67	WT-51-5017
V_3	Top and bottom vertical tails, 40° swept leading edge	7	WT-51-5019 WT-51-5021
V_6	Modified vertical tail and rudders	16,67	WT-52-5025
R_3	Both rudders for V_3	7	WT-51-5019 WT-51-5021
O_3	All 4 oleo struts	7,62	WT-51-5018
M_3	Both machine gun pods	7,62	WT-51-5013
F_3	Elevon actuator fairings	64	WT-51-5018
P	Propellers	7,63	WT-51-5029
Z_{10}	Leading edge tongue	13	
Z_{11}	Leading edge glove	14,66	
Z_{12}	Leading edge slat	15,68	